Operating Instructions

HETERODYNE FREQUENCY METER

TYPE TF. 1067

105/CA690

MARCONI INSTRUMENTS LIMITED, ENGLAND

MP MASTER

MA23685

MARCONI INSTRUMENTS

PBN/LSR.9.

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OPERATING INSTRUCTIONS

for

HETERODYNE FREQUENCY METER

TYPE TF 1067

Marconi Instruments Limited, St. Albans, Hertfordshire, England. Telephone: St. Albans 56161

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APPENDICES — Ref. No.

MAINS INPUT CONNECTION DIAGRAM ..... TLC 27612/1 (follows page 13)
FUNCTIONAL DIAGRAM ..... XD 30670
CIRCUIT DIAGRAM ..... TD 28913
OPERATIONAL SUMMARY AND HARMONIC TABLES .... in rear-cover pocket

SCHEDULE OF PARTS SUPPLIED

The complete equipment comprises the following items:-

1. One Heterodyne Frequency Meter Type TF 1067, complete with valves, etc., as follows:-

Valves:	Four:	Type 6AK5 (EF95), Pentodes.
	One:	Type 6922 (E88CC), Double Triode.
	One:	Type 12AT7 (ECC81), Double Triode.
	One:	Type 6X4 (EZ90), Full-Wave Rectifier.
Crystal:	One:	Marconi Type QO 1654B, 100-kc/s Oscillator Crystal.
Semiconductor:	One:	Type GEX54, Germanium Diode.
Lamp:	One:	6.3-volt, 0.15-ampere, M.B.C. Pilot Lamp.

2. One Mains Lead Type TM 2560/BD; 3-core; 6 ft long; one end normally fitted with a 3-pin, 5-ampere, mains plug, the other end with a Painton Type 500481 12-way socket.

3. One Coaxial Free Plug Type BNC.

4. One Instruction Book No. EB 1067.

The following item is an optional accessory, supplied only if specially ordered:-

5. One Battery Supply Lead Type TM 2560/BE; 4-core; 6 ft 9 in long; one end fitted with two spade terminals and two wander plugs; the other end with a Painton Type 500481 12-way socket.

1 DESCRIPTION

1.1 GENERAL

Heterodyne Frequency Meter Type TF 1067 covers the range 100 kc/s to 100 Mc/s and has an accuracy of better than 0.01%. It may be operated from either supply mains or external batteries, the change-over being made simply by plugging in an alternative supply lead.

The tuning dial is direct-reading over the fundamental range of the heterodyne oscillator (2 to 4 Mc/s) and is standardized by well over 400 easily-identified crystal check points. Signals above 4 Mc/s beat with harmonics of the variable oscillator and the dial reading is multiplied by the order of the harmonic; for frequencies below 2 Mc/s, harmonics of the signal beat with the fundamental of the variable oscillator and the dial reading is divided by the order of the harmonic.

Although frequencies outside the fundamental range can be positively identified and measured without the use of charts or tables, harmonic tables are included in the pocket at the end of this handbook to enable the user to make a rapid estimation of the approximate frequency and hence to check the answer obtained by the normal measurement procedure.

In addition to its normal role of general-purpose wavemeter, the TF 1067 is suitable for use as a frequency standard for mobile or low-power communication equipment, or as a transfer oscillator to extend the range of the Marconi TME 2 Precision Frequency Measuring Equipment. Since the output of the 2- to 4-Mc/s variable oscillator is available at a front-panel socket, the instrument can also be used as a signal source of accurately known frequency.

1.2 DESIGN DETAILS

The following circuit description is intended to be read in conjunction with the Functional Diagram and Circuit Diagram included at the end of this handbook. It can be seen from the Functional Diagram (Drawing No. XD 30670) that the Frequency Meter consists basically of a variable-frequency oscillator whose output is heterodyned with the signal under investigation, the resultant beat note being amplified and detected at a panel-mounted headphone jack.

1.2 (continued)

A crystal-controlled oscillator and divider can be switched into circuit to furnish a comprehensive series of check points.

1.2.1 Variable-Frequency Oscillator

The variable-frequency oscillator, V2a, uses a Hartley circuit. Its 2- to 4-Mc/s frequency range is covered by twenty revolutions of the main tuning dial; this is directly calibrated at intervals of 1 kc/s, while a second, concentric, dial geared to the main dial is calibrated every 100 kc/s.

The calibration can be standardized by crystal-controlled markers spaced at intervals of 10 kc/s. Between each of these markers there are up to three subsidiary beats produced by harmonics of the variable-frequency oscillator beating with harmonics of the 10-kc/s generator; by utilizing these additional points, frequencies can be measured with an accuracy approaching that of the crystal. 100-kc/s markers are provided in order to identify every tenth 10-kc/s point.

The tuning element, C4, is a special Marconi-patented cam-corrected capacitor. A cam, which is driven by the capacitor tuning spindle, controls the position of two auxiliary vanes meshing with the main stator vanes. The profile of this cam is formed by the tips of 44 set-screws which are preset so that the auxiliary vanes provide continuous correction for manufacturing tolerances as the capacitor is tuned throughout its range. As a result, the capacitor obeys a true straight-line-frequency law, the calibration being accurate and linear over the whole range.

Small changes in oscillator frequency can be made by means of C9, the CORRECTOR control. This enables the dial calibration to be aligned with the 10-kc/s check points.

1.2.2 Crystal Oscillator and Divider

The 100-kc/s crystal-controlled oscillator, V3, uses a close-tolerance crystal operating in a parallel-resonant mode. Temperature drift is minimized by using a crystal having a low power output and zero temperature coefficient at 40°C - the normal operating temperature inside the instrument.

1.2.2 (continued)

V7, a tuned-grid feedback-type frequency divider, may be switched into circuit to divide the 100-kc/s crystal output into 10-kc/s divisions. The grid leak and grid capacitor (RV1 and C21) are arranged to give a large phase shift at the frequency of operation. As the phase between the 100-kc/s and 10-kc/s signals changes, so does the effective phase shift in this grid circuit. This change is in the correct phase to lock the 10-kc/s signal to the output of the crystal oscillator.

In order to increase the high-order harmonics of the 100-kc/s and 10-kc/s check points, a harmonic amplifier, V5b, is used. The biasing voltage for Class C operation of this stage is obtained by driving the valve into grid current.

1.2.3 Input Amplifier

The input signal to be heterodyned against the 2- to 4-Mc/s oscillator is fed into a grounded-grid amplifier stage, V5a. This isolates the input and improves the sensitivity of the Frequency Meter. The incoming signal is applied to the cathode of the valve, an input impedance of the order of 50 ohms being obtained in this way. A germanium diode in the anode circuit clips the peaks of the input signal and increases the higher-order harmonics.

1.2.4 Mixer

Signals from the variable-frequency oscillator, input amplifier and crystal check circuits are each applied to the grid of the mixer valve, V2b. Both sum and difference frequencies appear at the anode of this valve, but a 0.01-μF capacitor (C13) by-passes the higher-frequency signal to earth. The remaining signal is coupled, via a low-pass filter, to the audio amplifier, V4.

When required, the output of the v.f.o. may be taken from socket SKT4 on the front panel of the instrument. This enables the Frequency Meter to be used as a 2- to 4-Mc/s signal generator or as a source of accurate 100- and 10-kc/s check points.

1.2.5 Audio Amplifier

Two pentode valves are used to amplify the heterodyne beat note produced by the mixer circuit. The first is used as a high-gain amplifier, and the second as a power output stage with transformer matching into either high- or low-impedance headphones. A variable potentiometer, RV2, acts as the SENSITIVITY control.

1.2.6 Power Supply

As mentioned in Section 1.1, the power supply can be obtained from either a.c. mains or external batteries.

The mains-operated power pack included in the instrument employs a 6X4 full-wave rectifier valve and a centre-tapped h.t. transformer. Smoothing is quite conventional, an iron-cored choke and electrolytic capacitors being used. The instrument may be operated from any 100- to 150-volt or 200- to 250-volt single-phase mains supply having a frequency of between 50 and 60 c/s.

A battery lead, available as an optional accessory, may be connected to a twelve-pin plug on the rear panel of the Frequency Meter. This operation automatically disconnects the a.c. power pack, but retains the use of the double-pole SUPPLY switch. The batteries should provide 135 volts at 30 mA and between 6.2 and 6.4 volts at 1.4 amperes.

2 OPERATION

2.1 INSTALLATION

Unless otherwise specified, the TF 1067 is normally despatched with its valves and crystal in position and with its mains input circuit adjusted for use with 240-volt a.c. mains. The instrument can, however, be adjusted to operate from any 50- to 60-c/s supply within the ranges 100 to 150 volts and 200 to 250 volts. To check or alter the setting of the mains input circuit, refer to Section 3.2 - MAINS INPUT ADJUSTMENTS.

For d.c. operation, the batteries should supply 135 volts at 30 mA and between 6.2 and 6.4 volts at 1.4 amps. For the 135-volt supply, three 45-volt batteries in series will probably be found most convenient.

2.2 SWITCHING ON AND WARMING UP

If the instrument is to be mains operated, ensure that the input circuit is correctly adjusted to suit the local supply voltage. Then connect the 3-core mains lead between the 12-pin plug on the rear of the instrument and a suitable source of supply.

If the instrument is to be operated from batteries, connect the 4-core lead to the 12-pin plug. The leads fitted with spade terminals are for the l.t. battery while those fitted with wander plugs are for the h.t. battery; in both cases, the red terminal should be connected to the positive side of the supply.

Having connected the power supplies, switch ON by means of the toggle switch on the front panel of the Frequency Meter. (Note that the power is ON when the switch toggle is up). The red indicator lamp above the SUPPLY switch should now light.

In order to allow the instrument to warm up and attain its specified accuracy (0.01%), measurements should not be attempted until at least 5 minutes have elapsed. When using the instrument as a transfer oscillator for the TME 2 (Section 2.4), this period should be extended to approximately 1 hour.

2.3 FREQUENCY MEASUREMENT

2.3.1 Setting Up

The MIXER INPUT socket on the front panel of the Frequency Meter is a 50-ohm type BNC connector; this mates with the following plugs:-

U.S. Mil. No.: UG-88/U
A.M. Ref. No.: 10H/20935

One mating free plug is normally supplied with the instrument.

The signal whose frequency is to be measured is connected to the MIXER INPUT socket, and a pair of headphones plugged into the PHONES jack; the instrument may be used with either high- or low-impedance headphones, but is normally wired ready for use with the former. To alter the output connections to suit headphones of low impedance, refer to Section 3.7.

With the headphones and input signal connected, set the selector switch to INPUT, and turn the SENSITIVITY control fully clockwise.

2.3.2 Measurements in the Range 2 to 4 Mc/s

The variable-frequency oscillator in the TF 1067 extends over the range 2 to 4 Mc/s; this fundamental range is covered by twenty revolutions of the main FREQUENCY dial. The dial is marked at 1- and 5-kc/s intervals, while intervals of 100kc/s are indicated on an outer, concentric, scale. Smaller increments can be determined by interpolation between the 1-kc/s divisions.

To make a measurement, proceed as follows:-

(1) Set up the Meter as described in Section 2.3.1, and turn the FREQUENCY dial until a strong beat note is heard.

(2) Note the indicated frequency and adjust the SENSITIVITY control to provide a note of convenient level.

(3) Temporarily disconnect the input signal and set the selector switch to XTAL. CAL. 100kc/s.

2.3.2 (continued)

(4) Turn the FREQUENCY dial to the nearest 100-kc/s check point, and adjust the CORRECTOR for zero beat in the headphones.

(5) Turn the input selector switch to XTAL CAL. 10 kc/s.

(6) Set the frequency dial at the nearest 10-kc/s division to the indicated signal frequency, as found in (2), and readjust the CORRECTOR for zero beat. For the highest possible accuracy, the subsidiary check points between the 10-kc/s divisions may be utilized; these occur over most of the range at intervals of 3.33, 5 and 6.66 kc/s and are distinguished from the main 10-kc/s points by their weaker beat note.

Should the frequency lie midway between two check points, verify that the same setting of the CORRECTOR control produces zero beats at both points; if there is any discrepancy, adjust the CORRECTOR so that the zero beats are symmetrically displaced on either side of the signal frequency.

(7) Turn the selector switch to INPUT, and reconnect the input signal. Tune for zero beat in the headphones and read off the frequency indicated on the dial. This is the frequency of the applied signal.

2.3.3 Measurements in the Range 100 kc/s to 2 Mc/s

When the frequency to be measured lies within the range 100 kc/s to 2 Mc/s, harmonics of the signal are heterodyned with the v.f.o. At some frequencies, several beat notes will be heard. For example: a signal of 1 Mc/s will produce harmonics at 2, 3 and 4 Mc/s, all of which will be heard in the headphones; similarly, a 500-kc/s signal will give beats at 2, 2.5, 3, 3.5 and 4 Mc/s.

From the above examples it can be seen that the interval between beat notes is the frequency of the applied signal. However, at some frequencies, e.g. 1.5 Mc/s, only one note will be heard - that due to the second harmonic (3 Mc/s); other harmonics will fall outside the range of the v.f.o. Since a signal frequency of 3 Mc/s will produce an identical response, it is necessary in such cases to have some idea of

2.3.3 (continued)

the approximate frequency of the signal before measuring it accurately on the TF 1067.

To summarize: if the signal is known to lie between 100 kc/s and 2 Mc/s, count the number of beat notes produced, ignoring the weaker, spurious, beats. If only one beat is present, the applied signal has a frequency equal to half that indicated on the dial; if there are two or more beats, the correct frequency is the interval between them.

An alternative method, which may be used when the frequency of the applied signal is already known to within about ±10%, is to tune the Frequency Meter to a harmonic of the expected frequency and then adjust the dial to determine the beat note nearest to this point. The actual frequency may then be calculated by dividing the frequency of the beat note by the order of the harmonic selected. For example: assume the applied frequency is known to be approximately 600 kc/s. Tune the Frequency Meter to 3.6 Mc/s (the sixth harmonic) and find the nearest beat note; if this is at 3.612 Mc/s, the actual frequency of the applied signal is $\frac{3.612}{6}$ Mc/s = 602 kc/s.

Whichever method is adopted, the measurement procedure is the same as that given in Section 2.3.2, i.e., note the beat frequency - adjust the CORRECTOR at the nearest 100-kc/s and 10-kc/s divisions - read the corrected frequency indication.

An appendix in the pocket at the end of this handbook gives a table of dial readings corresponding to harmonics of selected signals in the range 100 kc/s to 2 Mc/s.

2.3.4 Measurements in the Range 4 to 100 Mc/s

In the range 4 to 100 Mc/s, harmonics of the v.f.o. are heterodyned with the incoming signal to produce the necessary beat notes. At frequencies up to 6 Mc/s, only one beat will appear - that due to the second harmonic of the v.f.o.; at other frequencies, higher-order harmonics will also produce beats.

The harmonic table included in the appendix lists the beat notes produced by signals at various intervals up to 100 Mc/s. It is obviously

2.3.4 (continued)

impossible to list the beat notes for every frequency in the range, but sufficient have been included to enable the user to identify the approximate frequency of an unknown signal by the number of beat notes it produces and the interval between them. The exact frequency can then be calculated as follows:

Note the dial readings at three successive beats, and call them A, B and C.

The frequency of the applied signal is then

$$\frac{B \times A}{B - A} \text{ Mc/s}$$

It is also equal to

$$\frac{C \times B}{C - B} \text{ Mc/s}$$

The second calculation, which serves as a check, can be omitted if the frequency of the signal is known approximately; in this case only two readings, A and B are necessary, but they must represent successive beats.

For example: With a certain signal, beat notes are obtained at 2.15, 2.58 and 3.225 Mc/s. From the harmonic table, it is evident that the applied signal is very close to 13 Mc/s.

Therefore, taking the readings of 2.15 (A) and 2.58 (B):-

$$\text{Frequency} = \frac{2.58 \times 2.15}{2.58 - 2.15}$$

$$= \frac{5.547}{0.43}$$

$$= \underline{12.9 \text{ Mc/s}}$$

As a check:

$$\text{Frequency} = \frac{3.225 \times 2.58}{3.225 - 2.58}$$

$$= \frac{8.32}{0.64}$$

$$= \underline{12.9 \text{ Mc/s}}$$

2.3.4 (continued)

However, as the frequency is known to be very close to 13 Mc/s, the second equation can be omitted with little risk of obtaining the wrong answer.

An alternative method, similar to that given in Section 2.3.3, may be employed when the applied frequency is already known within about ±10%. This method consists of setting the Frequency Meter to one of the sub-harmonics of the expected frequency and then tuning the dial to determine the beat note nearest to this setting. The actual frequency may then be found by multiplying this beat-note frequency by the order of the sub-harmonic used. As an example: if the applied frequency is known to be 50 Mc/s ±10%, tune the Frequency Meter to, say, 2.5 Mc/s (the twentieth sub-harmonic) and find the nearest beat note; if this is at 2.574 Mc/s, the actual frequency is 2.574 x 20 = 51.48 Mc/s.

In both cases, the measurement procedure is identical to that given in Section 2.3.2. Care must be taken in selecting the required beat notes, however, as spurious beats may be caused by harmonics of the v.f.o. heterodyning with harmonics of the input signal. These spurious beats will normally be much weaker and less pronounced than the correct ones.

2.4 EXTENDING THE RANGE OF THE TME 2

By means of the TF 1067, the coverage of the TME 2 Precision Frequency Measuring Equipment may be extended up to 100 Mc/s. This is done by using the TME 2 to measure the frequency of the TF 1067 variable oscillator. The measurement accuracy is of the order of ±2 parts in 10^6.

To make use of this facility, proceed as follows:-

(1) Connect the signal under investigation to the input socket of the TF 1067; connect the output socket to the input of the TME 2.

(2) Set up the TF 1067 as detailed in Section 2.3 and tune for zero beat.

(3) Adjust the TME 2 to the frequency indicated on the dial of the TF 1067.

2.4 (continued)

(4) Make any fine adjustments to the TME 2, and thus determine the actual frequency of the TF 1067 variable oscillator.

(5) Knowing the exact frequency of this beat, it is possible to determine the frequency of the applied signal as described in Section 2.3.4.

2.5 USE AS A SIGNAL GENERATOR

Over the fundamental range of the variable-frequency oscillator (2 to 4 Mc/s), the TF 1067 may be used as a signal source of accurately-known frequency. In addition, harmonics of the v.f.o., up to about 50 Mc/s, may be used for the calibration of receivers, etc., which have a sufficiently high sensitivity.

When used as a signal generator, the instrument is set up as detailed in Sections 2.3.1 and 2.3.2, and the signal taken from the OSC. OUTPUT socket.

Use of the crystal markers results in an accuracy equal to that obtained when the instrument is used as a frequency meter.

3 MAINTENANCE

3.1 GENERAL

Before attempting the replacement or adjustment of any component part of the Frequency Meter, the user should study the principles and techniques dealt with in Section 1, DESCRIPTION, and illustrated in the Functional Diagram.

The Circuit Diagram at the end of this handbook shows all the electrical components of the instrument, together with their values, ratings, etc.

3.2 MAINS INPUT ADJUSTMENTS

BEFORE MAKING ANY ADJUSTMENTS ENSURE THAT THE MAINS CABLE IS DISCONNECTED FROM THE SUPPLY.

The Frequency Meter is suitable for operation from any 50- to 60-c/s supply within the ranges 100 to 150 volts and 200 to 250 volts. It is normally despatched with its mains input circuit adjusted for use with 240-volt supplies; adjustment to suit other voltages can be made by altering the primary connections to the mains transformer, as shown below.

The transformer has a double-wound primary, the two tapped sections of which are connected in series for 200- to 250-volt operation and in series-parallel for 100- to 150-volt operation. Tapping points for the selection of intermediate voltages within either range are brought out to a panel mounted on the rear of the instrument. The instrument covers need be removed only when it is required to change from one major voltage range to the other; when changing to another voltage within the same range it is only necessary to remove the perspex cover over the tapping panel and reposition the two screw-secured fly-leads to give a combination to suit the required voltage. For example: for 230-volt working secure the leads to the points marked "220" and "10"; for 240-volt working secure them to the points marked "240" and "0".

To change from one voltage range to the other, i.e., from the 200- to 250-volt range to the 100- to 150-volt range or vice versa, first remove

3.2 (continued)

the case from the instrument as described in Section 3.3.1. Reconnect the two soldered leads between the tags on the transformer as shown in the appropriate illustration on Drawing No. TLC 27612/1, following this page. Reverse the reference plate on the tapping panel to reveal the side marked with the voltages appropriate to the new range.

3.3 ACCESS TO COMPONENTS

3.3.1 Removal of Case

To remove the covers from the Frequency Meter, lay the instrument on its face (the front-panel surround protects the knobs and dial) and take out the chromium-plated screw in each corner of the rear panel. Remove the panel and slide off the one-piece case.

The Frequency Meter is built on two chassis: the a.c. power supply and a.f. sections are on the lower one, and the oscillator and mixer sections on the upper.

3.3.2 Removal of Screening Cover

A metal cover surrounds the oscillator section of the Frequency Meter. To remove this cover, take out the four 4-BA cheese-head screws in the top of the cover, and the ten 6-BA screws around the bottom sides.

3.4 WORKING VOLTAGES

The voltages given in this section were obtained from a representative Frequency Meter and are for guidance when servicing the instrument; the voltmeter used had a resistance of 20,000 ohms/volt.

3.4.1 Power Supplies

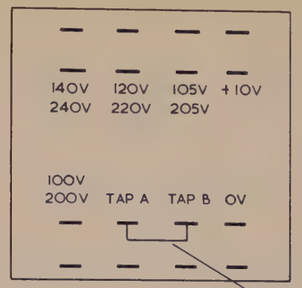
Transformer (Measured across the appropriate winding)

H.T. secondary	170 - 0 - 170 V a.c.
L.T. secondary	6.3 V a.c.

MAINS INPUT CONNECTIONS

100-150/200-250 VOLT PRI.

TRANSFORMERS



FOR

200-250 VOLTS MAINS SUPPLIES

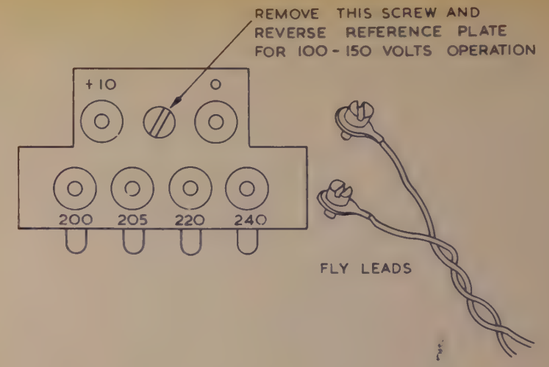
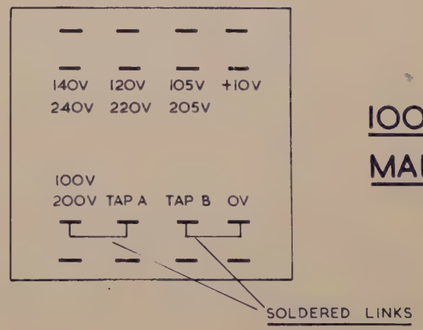
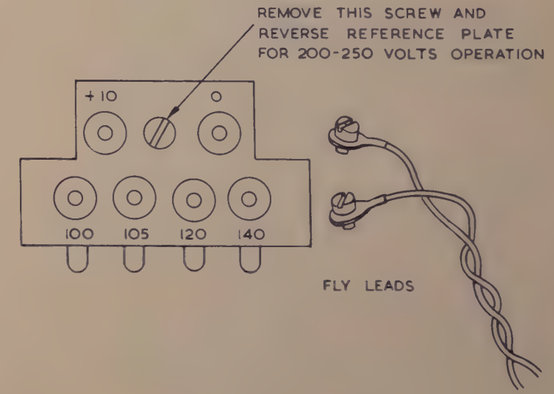


FIGURE 1.



FOR

100-150 VOLTS MAINS SUPPLIES



A ARRANGEMENT OF PRIMARY SOLDER TAG CONNECTIONS ON MAINS TRANSFORMER

B MAINS TAPPING PANEL
CONNECT THE FLY-LEADS TO GIVE A COMBINATION TO SUIT MAINS VOLTAGE - ONE FLY-LEAD MUST GO TO EITHER '+10' OR '0' TAP

FIGURE 2.

MAINS INPUT CONNECTIONS

MARCONI INSTRUMENTS LIMITED							
DRN.	A.B.R.	DATE	24-10-57	CHKD.		ISSUE	
STOCK LIST				DRG. No.	TLC 27612/1		

3.4.1 (continued)

H.T. Supplies

Unsmoothed (across C2) ..... 185 V d.c.
Smoothed (across C3) ..... 125 V d.c.

3.4.2 Valve Electrode Voltages

Valve	Anode	Screen	Cathode
V2a	83	-	0
V2b	30	-	0
V3	100	25	3.5
V4	27	25	0.7
V5a	100	-	0.3
V5b	100	-	0.1
V6	60	70	1.1
V7	125	45	0

3.5 REPLACEMENT OF VALVES AND CRYSTAL

The full-wave rectifier valve and the two a.f. pentodes are located on the lower chassis of the instrument and are readily accessible once the case has been removed.

The remaining valves, together with the marker crystal, are mounted on a small chassis beneath the oscillator screening cover; the crystal has a B7G base.

All valves may be replaced without special selection, although replacement of V2 may necessitate slight readjustment of L2 and C5 in the oscillator circuit (see Section 3.6.3). Normally, however, the variation will be small enough to be corrected by C9 - the front-panel CORRECTOR control.

3.6 ADJUSTMENT OF PRESET COMPONENTS

Following replacement of certain parts of the Frequency Meter, one or more of the preset components may have to be readjusted to maintain the instrument's performance. The following paragraphs detail these adjustments.

3.6.1 Location of Preset Components

All preset components are located underneath the oscillator screening cover. C5 is mounted on the rear of the plate supporting the small chassis and should be adjusted through the hole provided in the rear of the cover. L2 is also mounted on this plate, access being provided through a hole in the top of the cover. C32, the trimmer associated with the 100-kc/s crystal oscillator, is fitted on the small oscillator chassis and is accessible through a hole in the side of the cover.

Although holes for the adjustment of these components are provided, the cover must be removed and the locking devices slackened before any adjustments can be made. In the case of the capacitors, split collets and nuts are used to grip the slotted adjusting shafts; the threaded inductor core is held in a pinch clamp locked by a single 4-BA screw. Prior to making an adjustment, however, the cover should be replaced to avoid any detuning effect. After the necessary adjustments have been completed, tighten the locking devices and replace the oscillator cover.

Miniature potentiometer RV1 is mounted ona small brass pillar beneath the oscillator chassis. To adjust this, the cover must be removed completely.

3.6.2 Crystal Oscillator and Divider

Capacitor C32 enables the crystal oscillator to be tuned to a frequency of exactly 100 kc/s. With the instrument at operating temperature, inject a 100-kc/s signal at the INPUT socket and adjust C32 for zero beat.

The frequency divider, V7, is set up by means of preset potentiometer RV1. This is adjusted so that there are exactly ten 10-kc/s steps between each 100-kc/s division of the dial.

3.6.3 Variable Oscillator

The range of the variable-frequency oscillator should extend from 2 to 4 Mc/s and should obey a linear law, i.e., the 100-kc/s marker points should be equally spaced.

3.6.3 (continued)

If the range is incorrect, the following adjustments should be carried out:-

(1) Set the CORRECTOR to mid-travel, and the input selector switch to XTAL CAL. 100 kc/s.

(2) Turn the FREQUENCY dial to exactly 2.000 Mc/s and adjust L2 for zero beat.

(3) Tune to 4.000 Mc/s and adjust C5 for zero beat.

(4) Repeat steps (2) and (3) until no further adjustment is required.

Once L2 and C5 have been adjusted, tune to each 100-kc/s point in turn and check that the dial is correct; use the CORRECTOR control if necessary. If, at certain tuning-capacitor settings, the range of the CORRECTOR control appears to be insufficient, adjust the cam-corrected capacitor as follows:-

(1) Remove the oscillator screening cover and locate the 44 cheese-head screws controlling the cam at the rear of the main capacitor. It will be seen that, as the main capacitor is rotated, these screws move a cam which controls two auxiliary vanes.

(2) Set the screws on the cam ring so that the bottom of the head of each front screw is about 3/32 inch from the ring, and that of each rear screw about 5/32 inch.

(3) Loosen the cam clamping screws.

(4) Unscrew the second screw anticlockwise in the front row (looking from the front) by about 1/8 inch.

(5) With the dial set to 2.10 Mc/s, rotate the cam roller to bring it over this screw. The corrector vanes will dip to indicate the centre of the screw position. Repeat this procedure at 3.00 and 3.90 Mc/s, and spread any errors over the three points.

(6) Tighten the cam clamping screws.

3.6.3 (continued)

(7) Return the second screw to be $^3/_{32}$ inch from the cam ring, and set C9 to mid-travel.

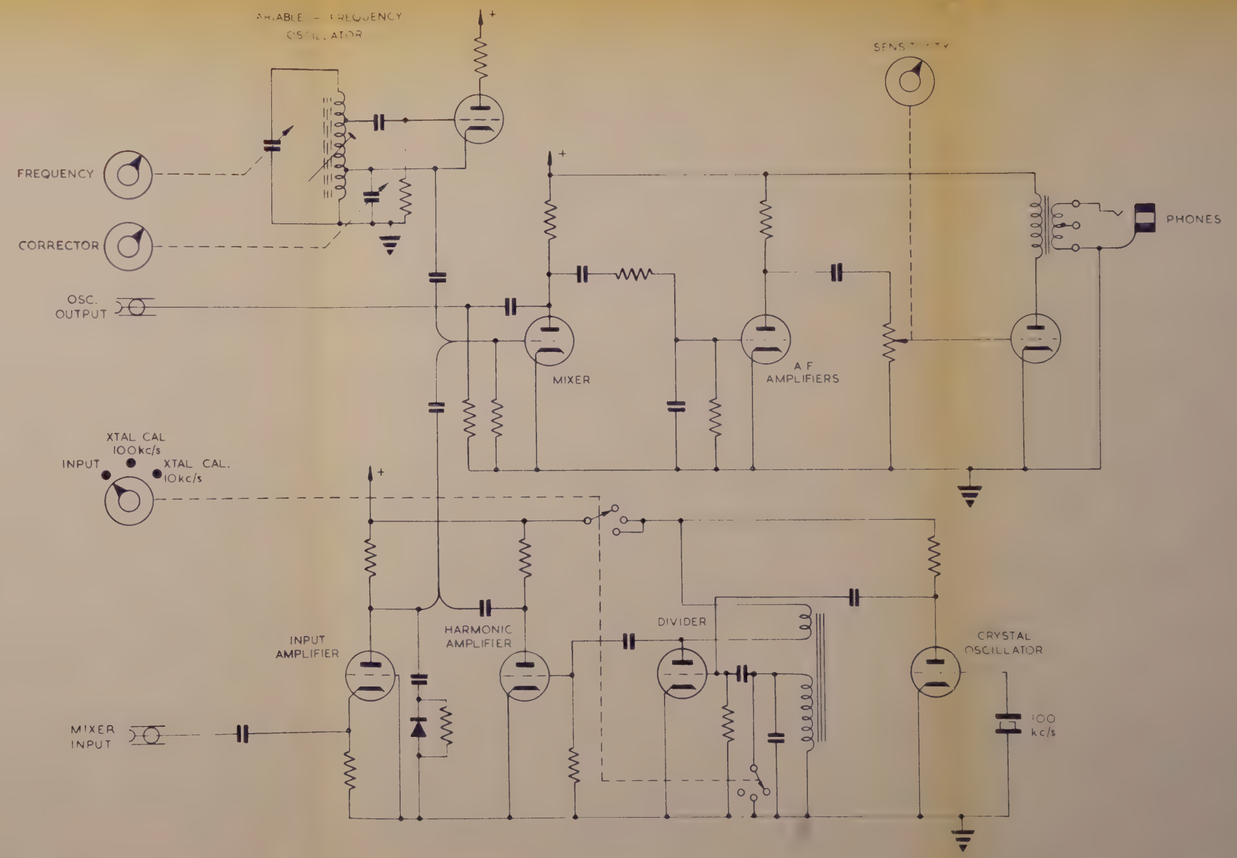
(8) Rotate the FREQUENCY dial from 2 to 4 Mc/s and, using the 100-kc/s markers, adjust the front row of screws so that the dial is correct at each 100-kc/s interval.

(9) Starting at 2.050 Mc/s, adjust the second row of screws until the dial is correct at each 100-kc/s interval from this frequency.

(10) Using the 10-kc/s markers, check at all points on the frequency scale, averaging any errors.

3.7 CHANGING THE OUTPUT IMPEDANCE

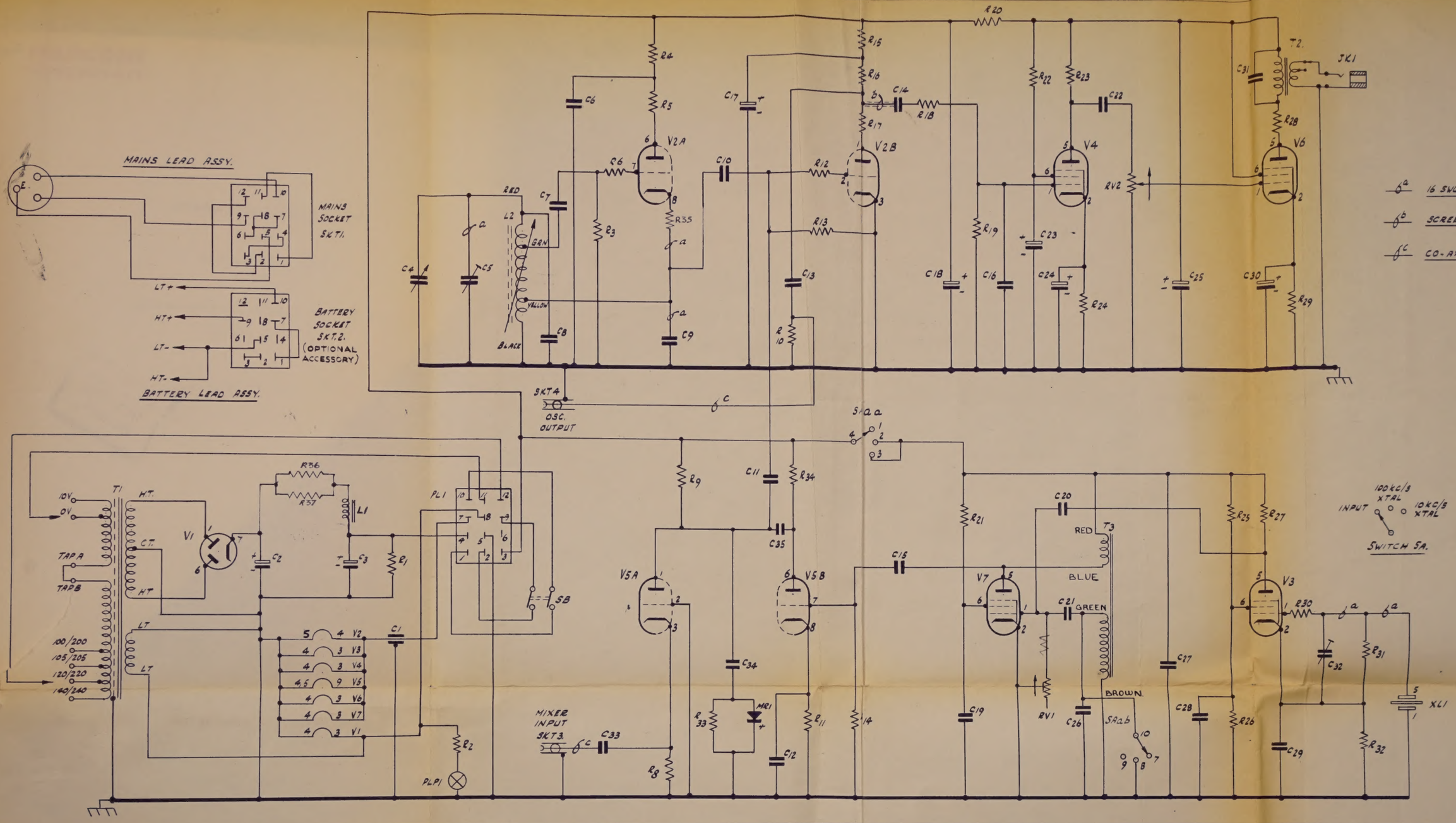
The output transformer, T2, is located at the front of the lower chassis of the Frequency Meter and is normally connected ready for use with high-impedance headphones (2,000 ohms). To alter the transformer for use with 150-ohm headphones, simply unsolder the output lead and reconnect it to the low-impedance tag. The tags are individually marked to avoid confusion.



FUNCTIONAL DIAGRAM OF HETERODYNE FREQUENCY METER TYPE TF 1067

TITLE	FUNCTIONAL DIAGRAM OF HETERODYNE FREQUENCY METER TYPE TF1067						
DRAWN	DATE	CHKD	APPD	TRCD	ASSEMBLY	STOCK LIST	DRAWING NUMBER
B P	8/59			E M T		TF 1067	XD 30670
MARCONI INSTRUMENTS LTD.							SHEET 1 OF 1 SHEETS

XD 30670



RESISTORS			S.L. REF.
100k	± 10%	½ W.	32/TM 5311/1
10Ω	± 10%	½ W.	30/TM 5311/1
22kΩ	± 10%	¼ W.	15/TM 5870
3·3kΩ	± 10%	¼ W.	18/TM 5870
68Ω	± 10%	¼ W.	17/TM 5870
68Ω	± 10%	½ W.	17/TM 5870
47Ω	± 10%	¼ W.	20/TM 5870
22kΩ	± 10%	¼ W.	15/TM 5870
100Ω	± 10%	¼ W.	29/TM 5870
470Ω	± 10%	¼ W.	28/TM 5870
22Ω	± 10%	¼ W.	27/TM 5870
22kΩ	± 10%	¼ W.	22/TM 5870
1MΩ	± 10%	¼ W.	24/TM 5870
6·8Ω	± 10%	½ W.	26/TM 5870
22kΩ	± 10%	½ W.	23/TM 5870
68Ω	± 10%	½ W.	17/TM 5870
330kΩ	± 10%	¼ W.	26/TM 5311/1
2·2 MΩ	± 10%	¼ W.	31/TM 5311/1
0kΩ	± 10%	½ W.	25/TM 5311/1
00kΩ	± 10%	¼ W.	19/TM 5870
330kΩ	± 10%	¼ W.	26/TM 5311/1
00kΩ	± 10%	¼ W.	28/TM 5311/1
·5kΩ	± 10%	¼ W.	27/TM 5311/1
00kΩ	± 10%	¼ W.	19/TM 5870

	RESISTORS VARIABLE		
RV1	25 kΩ VAR.		34/TM 5870
RV2	·5MΩ VAR. (LOG.)		72/TM 5870

				S.L. REF.
R26	22kΩ	± 10%	¼ W.	15/TM 5870
R27	100kΩ	± 10%	¼ W.	19/TM 5870
R28	220Ω	± 10%	¼ W.	29/TM 5311/1
R29	220Ω	± 10%	¼ W.	29/TM 5311/1
R30	47Ω	± 10%	¼ W.	20/TM 5870
R31	3·3 MΩ	± 10%	¼ W.	16/TM 5870
R32	10kΩ	± 10%	¼ W.	21/TM 5870
R33	100kΩ	± 10%	¼ W.	19/TM 5870
R34	22kΩ	± 10%	¼ W.	15/TM 5870
R35	1 KΩ	± 10%	¼ W	30/TM 5870
R36	2·2 KΩ	± 10%	½ W	34/TM 5311/1
R37	3·3KΩ	S.I.C.	½ W	35/TM 5311/1

REF	CAPACITORS		S.L. REF.
C1	4700 pf. FEED THROUGH		48/TM 5870
C2	32 µF. ELECT.	275V. D.C.	41/TM 5311/1
C3	32 µF. ELECT.	275V. D.C.	41/TM 5311/1
C4	VAR. CAP. 50-210 pF		/TM 5313
C5	TRIMMER LOCKING 3·3-22 pF		57/TM 5313
C6	·01 µF ± 20%	400V.	43/TM 5870
C7	47 pF ± 10%	750 V.	40/TM 5870
C8	4·7 pF. ± 10%	750V.	54/TM 5870
C9	VAR. CAP. 5-100 pF		75/ TF. 1067
C10	4·7 pF. ± ·5 pF	750 V.	44/TM 5870
C11	22 pF ± 20%	750 V.	49/TM 5870
C12	·01 µF ± 20%	400 V.	43/TM 5870
C13	·01 µF. ± 20%	400V.	43/TM. 5870
C14	·01 µF ± 20%	400V.	38/TM 5311/1
C15	1000 pF ± 20%	400 V.	42/TM 5870
C16	1000 pF ± 20%	400V.	40/TM. 5311/1
C17	32 µF ELECT.	275V. D.C.	45/TM 5870
C18	32 µF. ELECT.	275V. D.C.	45/TM 5870
C19	·01 µF ± 20%	400 V.	43/TM 5870
C20	22 pF. ± 20%	750 V	46/TM 5870
C21	500 pF ± 2% SILVER MICA.		47/TM 5870
C22	·01 µF. ± 20%	400V.	38/TM 5311/1
C23	16 µF. ELECT.	450 V.D.C.	37/TM 5311/1
C24	50 µF. +100% −20%	12 V. D.C.	30/TM 5311/1
C25	16 µF. ELECT.	450 V.D.C.	37/TM 5311/1

				S.L. REF.
C26	1000 pF	± 2% SILVER MICA		61/TM 5870
C27	·01 µF.	± 20%	400 V.	43/TM 5870
C28	·01 µF.	± 20%	400 V.	43/TM 5870
C29	1000 pF	± 20% SILVER MICA.		41/TM. 5870
C30	50 µF.	+100% −20%	12 V. D.C.	39/TM 5311/1
C31	·01 µF.	± 20%	400 V.	38/TM. 5311/1
C32	TRIMMER 5-50 pF			53/TM. 5870
C33	·1 µF	± 20%	150V.	52/TM. 5870
C34	·01 µF	± 20%	400V.	43/TM. 5870
C35	4·7 pF	± ·5 Pf	750V.	50/TM 5870

NOTE:- C2 & 3. C17 & 18. C23 & 25 ARE DOUBLE CAPACITORS

	VALVES		
V1	6X4	(CV 493)	80/ TF. 1067
V2	E88CC		79/TF. 1067
V3	6AK5	(CV 850)	81/ TF. 1067
V4	6AK5	CV 850)	81/TF. 1067
V5	12AT7	CV. 435)	82/TF 1067
V6	6AK5	(CV 850)	81/ TF. 1067
V7	6AK5	(CV 850)	81/ TF. 1067

	MISCELLANEOUS		
XL1	XTAL 100 kc/s		86/TF. 1067
MR1	DIODE IN 52		57/TM 5870
T1	TRANSFORMER MAINS		1/TM 5311/1
T2	TRANSFORMER AUDIO OUTPUT		2/TM 5311/1
T3	TRANSFORMER DIVIDER		1/TM 5870
L1.	SMOOTHING CHOKE		3/TM 5311/1
L2.	OSCILLATOR COIL		96/TF. 1067
SA	FUNCTION SW.		12/TF. 1067
SB	D. P. D. T.		4/TF. 1067

SKT1	MAINS SOCKET & LEAD ASSY.		4/ TF. 1067
SKT2	BATTERY SOCKET & LEAD ASSY.		5/ TF. 1067
SKT.3	SOCKET CO-AXIAL 50Ω		23/ TF. 1067
SKT.4	SOCKET CO-AXIAL 50Ω		23/ TF 1067
PL1	PLUG 12-WAY		14/TM 5311/1
JK1	PHONE JACK		24/ TF. 1067
PLP1	PANEL LAMP		79/ TF 1067

TITLE CIRCUIT DIAGRAM FOR HETERODINE FREQ. METER

DRN. K.H. WILLIAMSON.	ASSY. TE. 28912
DATE 18-12-58	S.LIST TF. 1067
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MARCONI INSTRUMENTS LTD.

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OPERATIONAL SUMMARY

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HARMONIC TABLES

for

HETERODYNE FREQUENCY METER

TYPE TF 1067

MP MASTER
MA23685